HEIDENHAIN

User's Manual

ND 720
ND 760

Position Display Units for Milling Machines

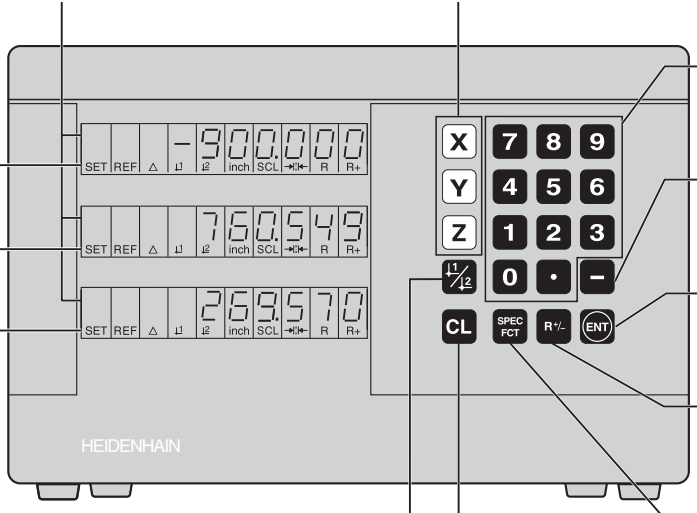
9/2000

Position display
(ND 720 only two axes)

- **Select coordinate axes (ND 720 only X and Y)**
- **Select axis-specific operating parameters**

Status display:

SET = Datum setting
REF = blinking:
Traverse the reference points.
On continuously:
Reference points have been traversed.
Δ = Distance-to-go display
1 2 Datum 1 or 2
Inch = Display in inches
SCL = Scaling factor
->||<- = Probing an edge / centerline
R = Radius/diameter display
R+/– = Radius compensation



Numerical input

- **Change the algebraic sign**
- **Call the last dialog**
- **In the parameter list: change parameters**
- **Confirm entry**
- **In the parameter list page forward**

Call radius compensation of the current tool

- **Select special functions**
- **In the list of special functions page forward**

- **Select datum 1 or 2**
- **Page backward in the list of special functions**
- **Page backward in the list of parameters**

- **Cancel entry**
- **Reset the operating mode**
- **Zero the selected axis (if activated in P80)**
- **Select parameters CL plus two-digit number**

This manual is for the ND display units with the following software numbers or higher:

ND 720 for two axes	**246 271-06**
ND 760 for three axes	**246 271-06**

About this manual

This manual is divided into two parts:

Part I: Operating Instructions

- Fundamentals of positioning
- ND functions

Part II: Installation and Specifications

- Mounting the display unit on the machine
- Description of operating parameters
- Switching inputs, switching outputs

Part I Operating Instructions

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Fundamentals

You can skip this chapter if you are already familiar with coordinate systems, incremental and absolute dimensions, nominal positions, actual positions and distance-to-go.

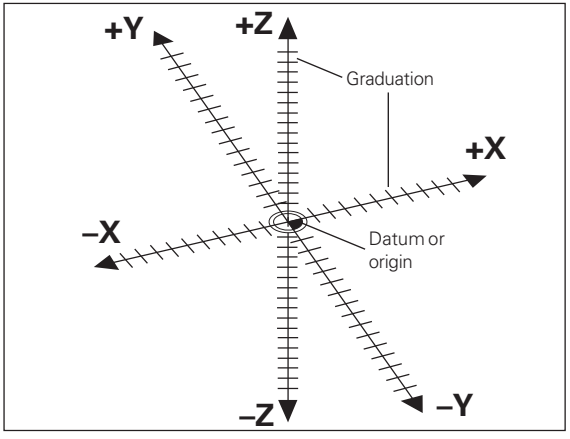
Coordinate system

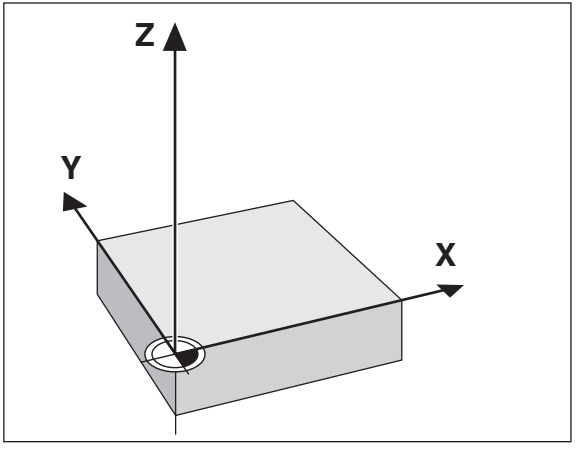
The *Cartesian*[1] coordinate system is used to describe the geometry of a workpiece. The Cartesian coordinate system consists of three mutually perpendicular axes X, Y and Z. The point of intersection of these axes is called the **datum** or origin of the coordinate system.

Think of the axes as scales with divisions (usually in millimeters) which allow us to fix points in space referenced to the datum.

To determine positions on a workpiece, the coordinate system is "laid" onto the workpiece.

The machine axes are parallel to the axes of the coordinate system. The Z axis is normally the tool axis.





[1] Named in honor of the French mathematician and philosopher René Descartes (1596 to 1650)

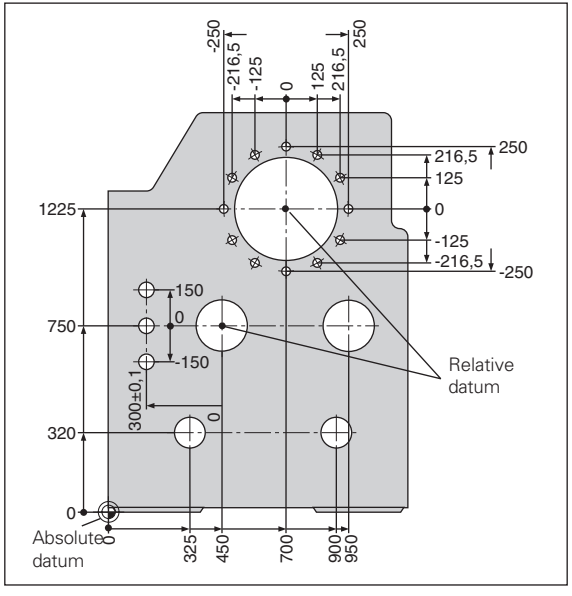
Datum setting

The workpiece drawing is used as the basis for machining the workpiece. To enable the dimensions in the drawing to be converted into traverse distances of machine axes X, Y and Z, each drawing dimension requires a datum or reference point on the workpiece (since a position can only be defined in relationship to another position).

The workpiece drawing always indicates **one** absolute datum (the datum for absolute dimensions). However, it may contain additional relative datums.

In the context of a numerical position display unit, *datum setting* means bringing the workpiece and the tool into a defined position in relation to each other and then setting the axis displays to the value that corresponds to that position. This establishes a fixed relationship between the actual positions of the axes and the displayed positions.

You can set 2 absolute datum points and store them in nonvolatile memory.



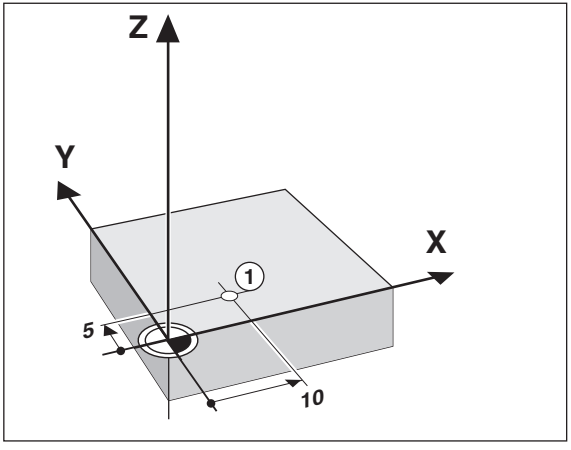
Absolute workpiece positions

Each position on the workpiece is uniquely defined by its absolute coordinates.

Example Absolute coordinates of position ①:

X = 10 mm
Y = 5 mm
Z = 0 mm

If you are working according to a workpiece drawing with absolute dimensions, then you are moving the tool **to** the coordinates.



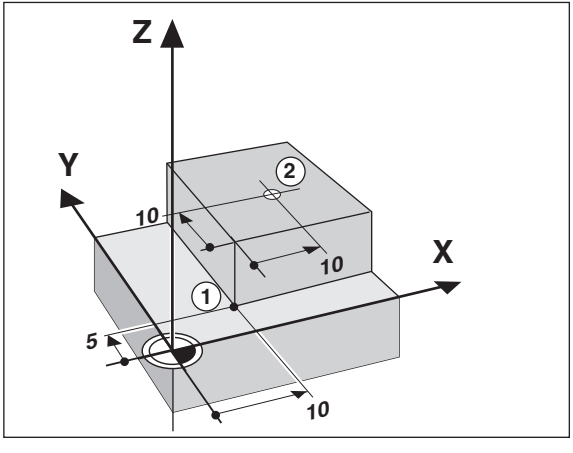
Relative workpiece positions

A position can also be defined relative to the previous nominal position. The datum for the dimension is then located at the previous nominal position. Such coordinates are termed **relative coordinates** or chain dimensions. Incremental coordinates are indicated by a preceding **I**.

Example Relative coordinate of position ② referenced to position ①:

IX = 10 mm
IY = 10 mm

If you are working according to a workpiece drawing with incremental dimensions, then you are moving the tool **by** the dimensions.



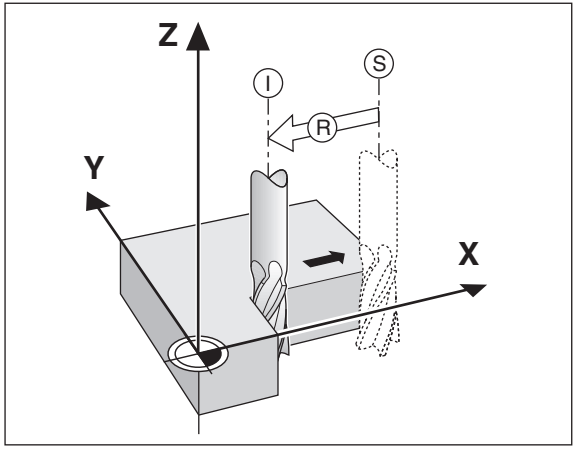
Sign for incremental dimensioning

A relative dimension has a **positive** sign when the axis is moved in the positive direction, and a **negative** sign when it is moved in the negative direction.

Nominal position, actual position and distance-to-go

The position to which the tool is to move is called the **nominal** position (Ⓢ). The position at which the tool is actually located at any given moment is called the **actual** position (Ⓘ).

The distance from the nominal position to the actual position is called the distance-to-go (Ⓡ).



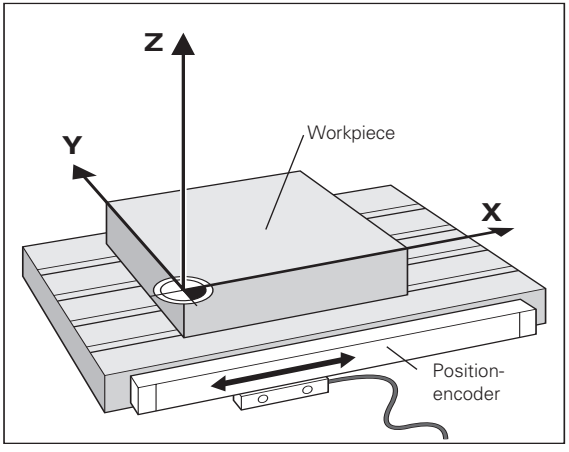
Sign for distance-to-go

When you are using the distance-to-go display, the nominal position becomes the relative datum (display value 0). The distance-to-go is therefore negative when the tool moves in the positive axis direction, and positive when it moves in the negative axis direction.

Position encoders

The position encoders on the machine convert the movements of the machine axes into electrical signals. The ND display unit evaluates these signals, determines the actual position of the machine axes and displays the position as a numerical value.

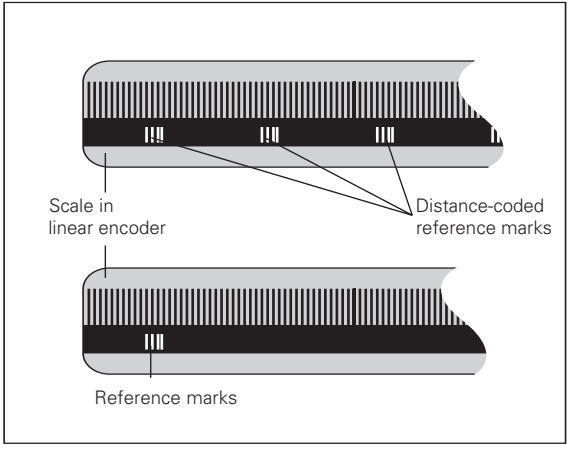
If the power is interrupted, the relationship between the machine axis positions and the calculated actual positions is lost. The reference marks on the position encoders and the REF reference mark evaluation feature enable the ND to quickly reestablish this relationship again when the power is restored.



Reference marks

The scales of the position encoders contain one or more reference marks. When a reference mark is crossed over, a signal is generated which identifies that position as a reference point (scale datum = machine datum).

When this reference mark is crossed over, the ND's reference mark evaluation feature (REF) restores the relationship between axis slide positions and display values which you last defined by setting the datum. If the linear encoders have **distance-coded** reference marks, you only need to move the machine axes a maximum of 20 mm to do this.



Switch-On, Traversing the Reference Marks

0 → 1	Turn on power (switch located on rear panel). "REF" in status display starts blinking.
ENT...CL	
ENT	Confirm reference traverse mode. "REF" remains on continuously. Decimal points start blinking.
	Cross over the reference marks in all axes in any sequence. Each axis display becomes active when its reference mark is crossed over.

Crossing over the reference marks stores the most recently defined assignment of display values to axis slide positions for datum points 1 and 2 in nonvolatile memory.

Note that if you choose *not* to traverse the reference marks (by clearing the dialog ENT ... CL with the CL key), this relationship will be lost if the power is interrupted or when the unit is switched off.

If you wish to use multipoint axis error compensation you must traverse the reference marks (see "Multipoint axis error compensation")!

Datum Setting

If you want to save the datum points in nonvolatile memory, you must first cross over the reference marks.

Only after crossing over the reference marks can you set new datums or activate existing ones.

In P70, you can select:
- Two datum points: The selected datum point is displayed via |1_ or |2_
- Nine datum points: The selected datum point is displayed in the lowest axis via d1 to d9.

There are two ways to set datums:

Touch the workpiece with the tool and then set the desired datum (see example). You can also touch two edges and set the centerline between them as a datum. The dimensions of the tool used for this are automatically accounted for (see "Tool Compensation").

Probe the workpiece with the edge finder and then set the desired datum. You can also probe two edges and set the centerline between them as a datum, or touch the inside of a circle and set the circle center as a datum (see examples). The stylus radius and length are automatically accounted for if they have been entered in parameters P25 and P26, respectively (see "Operating Parameters").

To call a datum you have set, proceed as follows:

You have set two datum points in P70:

1/2	Select datum 1 or 2.

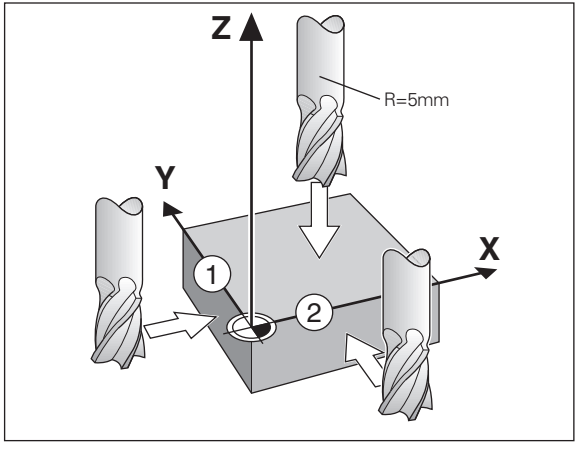
You have set nine datum points in P70:

1/2	Press the datum key ("d" starts blinking).
1 ENT	Enter a datum number (1 to 9).

Datum setting with the tool

Example:

Working plane	X / Y
Tool axis	Z
Tool radius	R = 5 mm
Axis sequence for datum setting	X – Y – Z



[1/2]	Select a datum number (see page 10).
SPEC FCT	Select the special functions.
SPEC FCT or [1/2]	Select "probing function."
PROBING	
ENT	Confirm selection.
PROBE EDGE	
ENT	Confirm "Probe edge."
X	Select X axis (if not already selected). SET lights. The I<- symbol starts to blink.

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PROBE X (appears only briefly)

Touch workpiece edge ① with the tool.

ENT

X position is captured. "SET edge" is shown briefly. SET starts blinking.
Retract tool from workpiece.
The I<- status symbol lights.

0 ENT

Enter position value for the datum.
Tool radius is automatically compensated.

Y

Select the Y axis. "SET" lights.
The I<- status symbol starts blinking.

PROBE Y (appears only briefly)

Touch workpiece edge ② with the tool.

ENT

Y position is captured. "SET edge" is shown briefly. SET starts blinking.
Retract tool from workpiece.
The I<- status symbol lights.

0 ENT

Enter position value for the datum in the Y axis. Tool radius is automatically compensated.

Z

Select the Z axis. "SET" lights.
The I<- status symbol starts blinking. [1)]

PROBE Z (appears only briefly) [1)]

Touch the top of the workpiece with the tool.

ENT

Z position is captured. "SET" edge is shown briefly. SET starts blinking.
Retract the tool from the workpiece.
The I<- status symbol lights. [1)]

0 ENT

Enter the position value for the datum in the Z axis. [1)]

SPEC FCT or CL

After setting the datum, exit the probing functions.

[1)] only with ND 760

Datum setting with the KT Edge Finder

The ND position display units provide the following probing functions:

"PROBE EDGE"	Setting a workpiece edge as datum
"PROBE MIDPOINT"	Setting a midpoint between two workpiece edges as datum
"PROBE CIRCLE"	Setting the center of a circle as datum

The probing functions are accessible in the SPEC FCT mode of operation.

Before using the edge finder you must enter the stylus diameter and length in parameters P25 and P26, respectively (see "Operating Parameters").

During all probing functions, the ND position display unit accounts for the entered dimensions.

The "PROBE EDGE", "PROBE MIDPOINT" and "PROBE CIRCLE" functions are described on the following pages.

Probing a workpiece edge to find a datum

The edge to be probed is parallel to the Y axis. You can probe edges and surfaces as described below to set all the coordinates of a datum.

1/2	Select a datum number (see page 10).
SPEC FCT	Select the special functions.
SPEC FCT 1/2	Select "probing functions."
PROBING	
ENT	Confirm "probing" function.
PROBE EDGE	
ENT	Confirm "probe edge" function.

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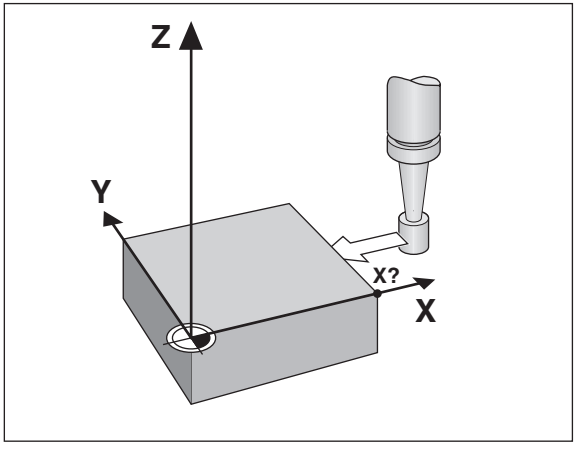

X	Select the X axis (if not already selected). "SET" lights. The I< status symbol starts blinking.

PROBE X (appears only briefly)

	Move the edge finder to edge of workpiece until indicator in edge finder lights. "SET edge" is shown briefly. SET starts blinking. The ND displays the position of the edge. The I< status symbol lights.
	Back the edge finder away from the workpiece.
5 2 ENT	Assign a position value to this edge, e.g. 52.
SPEC FCT or CL	Exit the probing function.

Probing workpiece edges to find a midpoint datum

The edges to be probed run parallel to the Y axis.

Follow the procedure below for all midpoints between two edges.

[1/2]	Select a datum number (see page 10).
SPEC FCT	Select the special functions.
SPEC FCT or [1/2]	Select the probing function.
PROBING	
ENT	Confirm the probing function.
PROBE EDGE	
[1/2] or –	Select the midpoint probing function.

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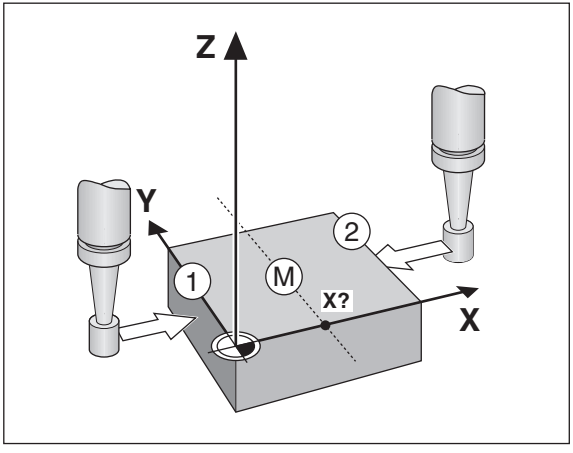

PROBE MIDP.

ENT — Confirm the "probe midpoint" function. "SET" lights.

X ENT — Select the X axis (if not already selected) and confirm with ENT. The ->‖<- status symbol starts blinking.

1ST POS X (appears only briefly)

— Move edge finder toward workpiece edge ① until the indicator in the edge finder lights. Back edge finder away from the workpiece.

2ND POS X (appears only briefly)

— Move edge finder toward workpiece edge ② until the indicator in the edge finder lights. "SET MIDPOINT" is shown briefly. SET" begins to blink. Back the edge finder away from the workpiece. The ->‖<- symbol begins to blink.

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2 6 ENT — Set the position value for the midpoint between the edges, e.g. 26.

SPEC FCT or CL — Exit the probing functions.

Probing the inside of a circle to set its center as datum

To determine the circle center, the tool must probe four points. The points to be probed are located in the X-Y plane.

I1/I2	Select a datum number (see page 10).
SPEC FCT	Select the special functions.
SPEC FCT or I1/I2	Select the probing function.
PROBING	
ENT	Confirm the probing function.
PROBE CIRC.	
I1/I2 or −	Select the circle probing function.

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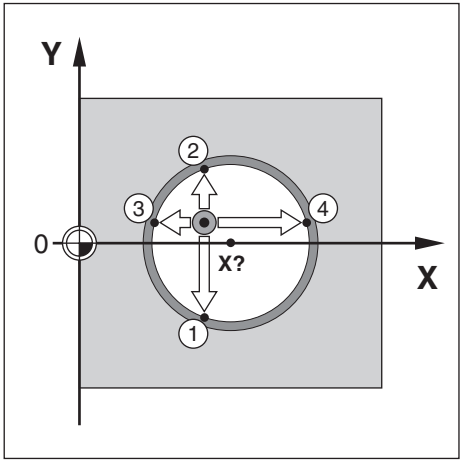

PROBE CIRC.

ENT — Confirm "Probe circle."

1ST POS X (appears only briefly)

— Move edge finder toward position ① until the indicator in the edge finder lights. Back edge finder away from workpiece.

2ND POS X (appears only briefly)

— Move edge finder toward position ② until the indicator in the edge finder lights. Back edge finder away from workpiece.

3RD POS Y (appears only briefly)

— Move edge finder toward position ③ until the indicator in the edge finder lights. Back edge finder away from workpiece.

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4TH POS Y (appears only briefly)

— Move edge finder toward position ④ until the indicator in the edge finder lights. "CENTER X" is shown briefly. The SET status display starts to blink in the X axis.

2 6 ENT — Enter position value for the X coordinate of circle center, e.g. 26. "CENTER Y" is shown briefly. The SET status display starts to blink in the Y axis.

0 ENT — Enter position value for the Y coordinate of circle center, e.g. 0.

SPEC FCT or CL — Exit the probing functions.

Tool Compensation

You can enter the axis, length and diameter of the current tool.

SPEC FCT	Select the special functions.

SPEC FCT or ↓1/↓2	Select “tool data”.

TOOL DATA	
ENT	Confirm tool data input mode.

TOOL DIAM.	
2 0 ENT	Enter the tool diameter, e.g. 20 mm, and confirm with ENT.

TOOL LENGTH	
5 0 ENT	Enter the tool length, e.g. 50 mm, and confirm with ENT.

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TOOL AXIS	
Z	Set the tool axis.

TOOL AXIS	
SPEC FCT or CL	Exit the special functions.

1) only with ND 760

Moving the Axes with Distance-To-Go Display

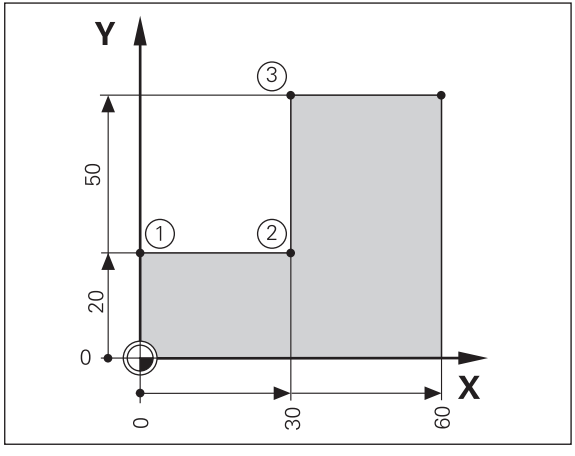
Normally, the display shows the actual position of the tool. However, it is often more helpful to display the distance remaining to the nominal position (the distance-to-go). You can then position simply by moving the axis until the display value is zero.

You can enter the absolute coordinates in the distance-to-go display. An active radius compensation will be considered.

Example: Milling a shoulder with distance-to-go

SPEC FCT	Select the special functions.
SPEC FCT or Δ1/Δ2	Select "delta mode."
DELTA MODE	
ENT	Confirm your selection, the Δ symbol lights.
Y 2 0 R+/- ENT	Select the axis, enter the nominal value, e.g. 20 mm, select radius compensation R+, confirm with ENT.

	Move the machine axis to zero (①).
X 3 0 R+/− R+/− ENT	Select the axis, enter the nominal value, e.g. 30 mm, select radius compensation R–, and confirm with ENT.
	Move the machine axis to zero (②).
Y 5 0 R+/− ENT	Select the axis, enter the nominal value, e.g. 50 mm, select radius compensation R+, confirm with ENT.
	Move the machine axis to zero (③).
SPEC FCT ENT or CL	If appropriate, switch off the distance-to-go display.



Bolt Hole Circles and Bolt Hole Circle Segments

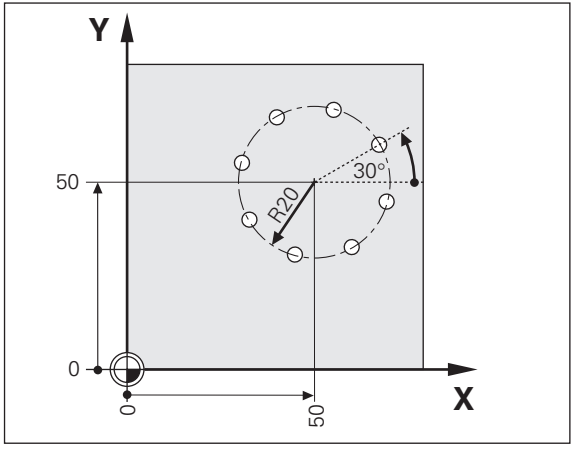
Your display unit enables you to quickly and easily produce bolt hole circles and bolt hole circle segments. The required data is requested in the message field.

Each hole can be moved to by traversing to display value zero. This requires entry of the following data:

- Number of holes (maximum: 999)
- Circle center
- Circle radius
- Starting angle for first hole
- Angle step between the holes (only for circle segments)
- Hole depth

Example

Number of holes	8
Coordinates of the center	X = 50 mm
	Y = 50 mm
Circle radius	20 mm
Starting angle	30 degrees
Hole depth	Z = –5 mm



SPEC FCT	Select the special functions.

SPEC FCT or ↓1/↓2	Select "bolt hole" circle.

BOLT HOLE

ENT	Confirm your selection.

FULL CIRCLE

if req. – ENT	Confirm "full circle."

NUMB. HOLES

8 ENT	Enter the number of holes, e.g. 8. Confirm with ENT.

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CENTER X

5 0 ENT	Enter the X coordinate of circle center, e.g. 50 mm, confirm with ENT.

CENTER Y

5 0 ENT	Enter the Y coordinate of circle center, e.g. 50 mm, confirm with ENT.

RADIUS

2 0 ENT	Enter the radius of the bolt hole circle, e.g. 20 mm. Confirm with ENT.

START ANGLE

3 0 ENT	Enter the start angle for the first hole, e.g. 30°. Confirm with ENT.

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HOLE DEPTH [1)]

5 – ENT	Enter the total hole depth, e.g. –5 mm, and confirm with ENT.

START

ENT	Start the display of the hole positions.
ENT ↓1/↓2	After the start, the distance-to-go mode becomes active (the Δ symbol lights). The hole number is shown briefly in the X axis. The individual holes are reached by traversing to zero. The holes can be selected with the ENT key or the ↓1 ↓2 key. The minus key shows the hole number again.
SPEC FCT or CL	Exit the bolt hole circle function.

[1)] only with ND 760

Linear Hole Patterns

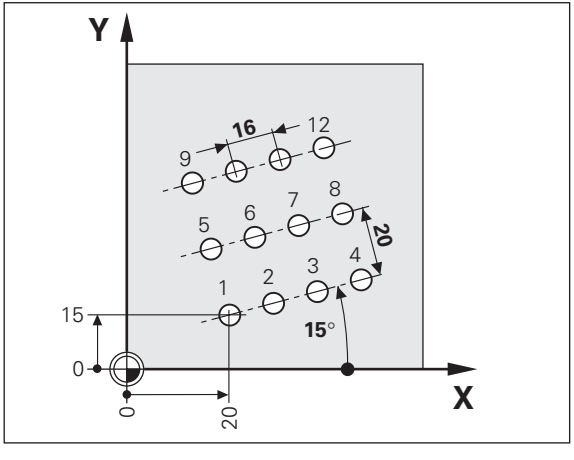
The linear hole pattern feature allows you to easily create rows of holes to cover an area. The required data are requested in the message field.

You can position to each hole by traversing to display value zero. The following data are required:

- Coordinates of the first hole
- Number of holes per row (maximum: 999)
- Spacing between holes
- Angle between the rows and the reference axis
- Hole depth
- Number of rows (maximum: 999)
- Spacing between rows

Example

Coordinates of the first hole	X = 20 mm
	Y = 15 mm
Number of holes per row	4
Spacing between holes	16 mm
Angle	15 degrees
Hole depth	Z = -30 mm
Number of rows	3
Spacing between rows	20 mm



SPEC FCT	Select the special functions.
SPEC FCT or ↓1/↓2	Select "hole pattern".

LIN. HOLE

ENT	Confirm "linear hole" pattern.

1ST HOLE X

2 0 ENT	Enter the X coordinate of the first holes, e.g. 20, and confirm with ENT.

1ST HOLE Y

1 5 ENT	Enter the Y coordinate of the first holes, e.g. 15, and confirm with ENT.

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HOLES ROW

4 ENT	Enter the number of holes per row, e.g. 4, and confirm with ENT.

HOLE SPACE

1 6 ENT	Enter the spacing between holes in the row and confirm with ENT.

ANGLE

1 5 ENT	Enter the angle, e.g. 15 degrees, and confirm with ENT.

HOLE DEPTH [1)]

3 0 – ENT	Enter the hole depth, e.g. –30 mm, and confirm with ENT.

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[1)] only with ND 760

NUMBER ROW	
3 ENT	Enter the number of rows, e.g. 3, and confirm with ENT.

ROW SPACE	
2 0 ENT	Enter the spacing of the rows, e.g. 20, and confirm with ENT.

START	
ENT	Start the display of hole positions.

ENT ↓1/↓2	The distance-to-go mode is now active (the Δ symbol lights). The hole number appears briefly in the X axis. Move to the individual hole positions by traversing to the display value zero. Hole can be selected with the ENT key or with the ↓1 ↓2 key. Pressing the minus key shows the hole number again.

SPEC FCT or CL	Exit the linear hole patterns function.

Working with a Scaling Factor

Scaling factors enable you to increase or decrease the display values based on the actual traverse distance. The display values are changed symmetrically about the datum.

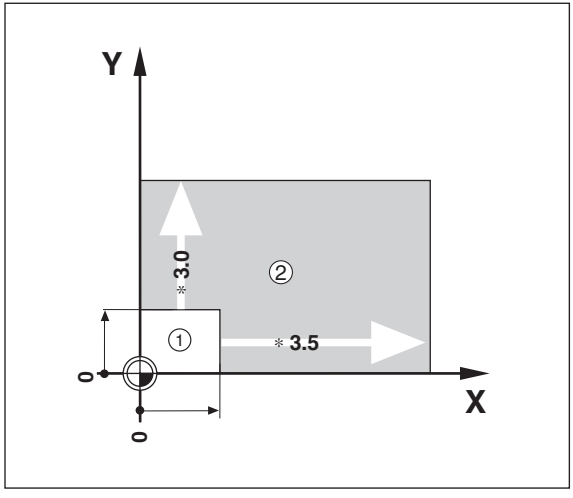
Enter scaling factors separately for each axis in parameter P12.

Parameter P11 activates and deactivates the scaling factors in all axes (see "Operating Parameters").

Example for enlarging a workpiece:

P12.1	3.5
P12.2	3.0
P11	ON

This results in a larger workpiece as shown in the illustration at right: ① is the original size, ② is with axis-specific scaling factors.



If a scaling factor is active, "SCL" lights in the status display.

Error Messages

Message	Cause and Effect
`V.24 TOO FAST`	Time interval between two commands too short.
`SIGNAL X`	Encoder signal is too weak, e.g. when an encoder is contaminated.
`PROB. ERROR`	Before touching off on the workpiece, the tool must move by a distance of at least 0.2 mm.
`DSR MISSING`	The connected device is not transmitting a DSR signal.
`ERR. REF. X`	The spacing of the reference marks as defined in P43 is not the same as the actual spacing.
`FORMAT. ERR.`	Data format, baud rate etc. do not match.
`FRQ. ERR X`	The input frequency for this encoder input is too high. This can occur when the scale is moved too fast.
`ERR. MEMORY`	Check sum error: Check the datum, operating parameters and compensation values for multipoint axis error compensation. If the error recurs, contact your service agency!

To erase error messages:
After you have removed the cause of error:
➤ Press the CL key.

Part II Installation and Specifications

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Items Supplied

- **ND 720** for 2 axes
  or
- **ND 760** for 3 axes

- **Power connector** Id. Nr. 257 811-01

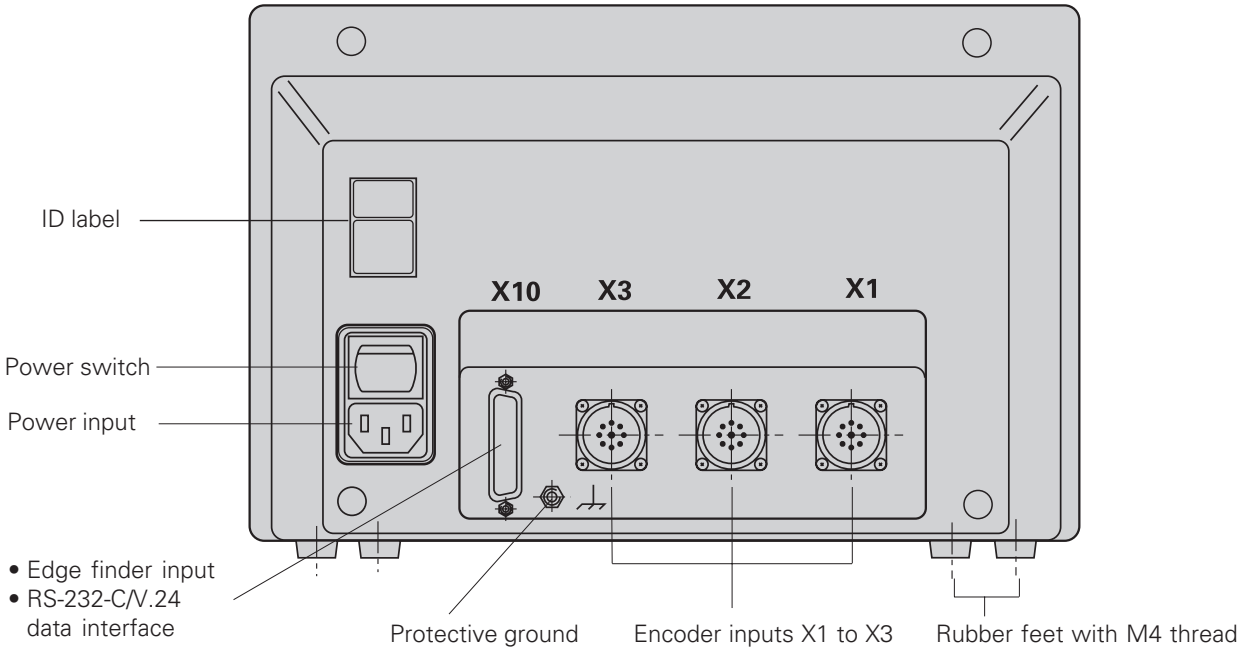
- **User's Manual**

Optional Accessories

- **Tilting base** for housing bottom
  Id. Nr. 281 619-01

- **KT 130 Edge Finder** Id. Nr. 283 273-01

Connections on Rear Panel

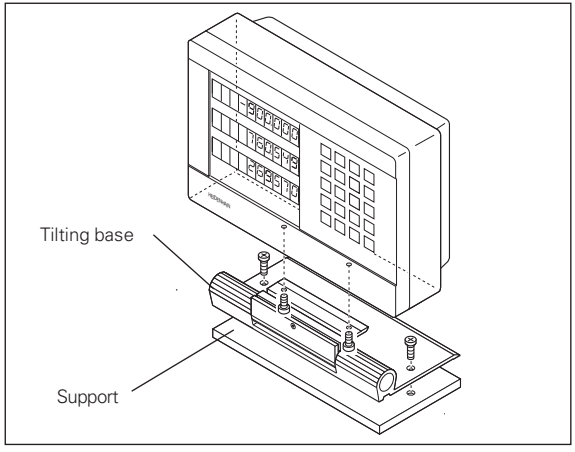


The interfaces X1, X2, X3, and X10 comply with the requirements for electrical separation according to EN 50178!

Mounting

ND 720/ND 760

To mount the display unit on a support, use the M4 threaded holes in the rubber feet. You can also mount the display unit on the optional tilting base.

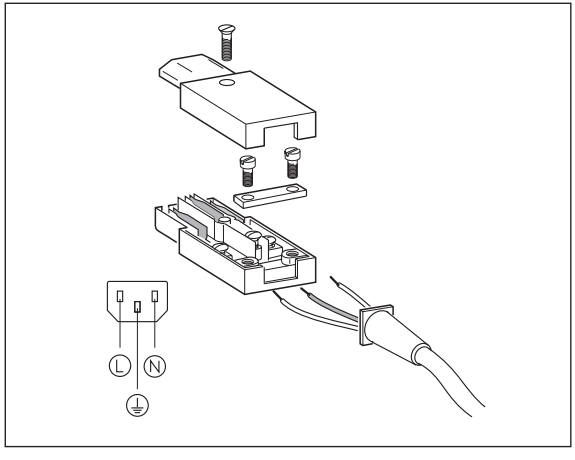


Power Connection

Power leads: Ⓛ and Ⓝ
Connect protective ground to ⏚ !

Power supply: 100 Vac to 240 Vac (-15 % to +10 %)
50 Hz to 60 Hz (± 2 Hz)

A voltage selector is not necessary.



- **Danger of electrical shock!**
  Connect a protective ground. This connection must never be interrupted.
- Unplug the power cord before opening the housing.

To increase the noise immunity, connect the ground terminal on the rear panel to the central ground point of the machine. (Minimum cross-section: 6 mm²).

Connecting the Encoders

Your display unit will accept all HEIDENHAIN linear encoders with sinusoidal output signals (7 to 16 μA_{pp}) and distance-coded or single reference marks.

Assignment of the encoder inputs

Encoder input X1 is for the X axis
Encoder input X2 is for the Y axis
Encoder input X3 is for the Z axis (ND 760 only)

Encoder monitoring system

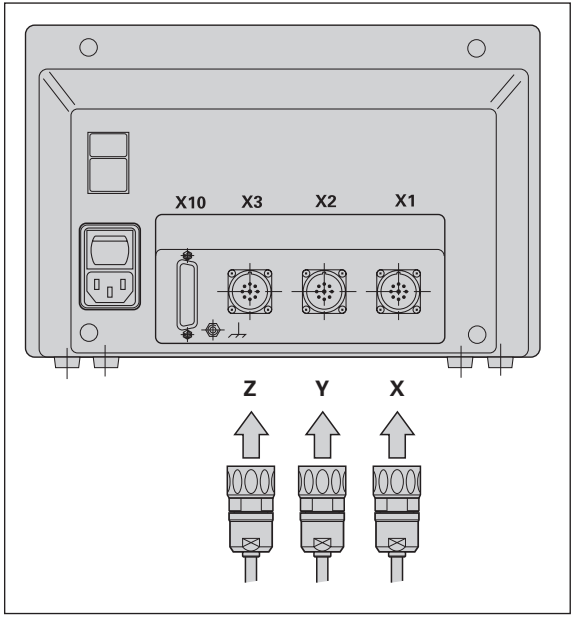
Your display unit features a monitoring system for checking the amplitude and frequency of the encoder signals. If it detects a faulty signal, one of the following error messages will be generated:

```
SIGNAL X
FRQ. X
```

Encoder monitoring can be activated with parameter P45.

If you are using linear encoders with distance-coded reference marks, the encoder monitoring system also checks whether the spacing of the reference marks as defined in parameter P43 is the same as the actual spacing on the scales. If it is not, the following error message will be generated:

```
ERR. REF. X
```



Operating Parameters

Operating parameters allow you to modify the operating characteristics of your display unit and define the evaluation of the encoder signals. Operating parameters that can be changed by the user are called user parameters, and can be accessed with the SPEC FCT key and the dialog "PARAMETER" (user parameters are identified as such in the parameter list). The full range of parameters can only be accessed through the dialog "CODE" and by entering 95148.

Operating parameters are designated by the letter P and a number. Example: **P11.** The parameter designation is shown in the input field when you select it with the DATUM and ENT key in the X display. The parameter setting is shown in the Y display.

Some operating parameters have separate values for each axis. In the **ND 760,** these parameters are identified by an index of 1 to 3, and in the **ND 720** by an index of one to two.

Example: P12.1 scaling factor, X axis
P12.2 scaling factor, Y axis
P12.3 scaling factor, Z axis (ND 760 only)

The operating parameters are preset before the unit leaves the factory. These factory default settings are indicated in the parameter list in **boldface type**.

Entering and changing operating parameters

To access the operating parameters

- ➤ Press the SPEC FCT key.
- ➤ Press the SPEC FCT key or 1 2 , until "PARAMETER" appears in the X display.
- ➤ Confirm your selection by pressing ENT.

To select protected operating parameters

- ➤ Press the 1 2 key to select the P00 CODE user parameter.
- ➤ Enter the code number 95148.
- ➤ Confirm with the ENT key.

To page through the operating parameters

- ➤ Page forwards by pressing the ENT key.
- ➤ Page backwards by pressing the 1 2 key.

To change parameter settings

- ➤ Press the minus key or enter the value and confirm with the ENT key.

To correct an entry

- ➤ Press CL: the old value reappears in the input line and becomes effective again.

To exit the operating parameters

- ➤ Press the SPEC FCT or CL key.

P00 CODE Enter code number

9 51 48:	Change protected operating parameters
66 55 44:	Display software version (in the X axis) Display date of release (in the Y axis)
10 52 96:	Multipoint axis error compensation

P1 Unit of measure [1)]

Display in millimeters	MM
Display in inches	INCH

P3.1 to P3.3 Radius/diameter display [1)]

Display position value as radius	**RADIUS**
Display position value as diameter	DIAMETER

P11 Activate scaling factor [1)]

Active	SCALING ON
Not active	**SCALING OFF**

P12.1 to P12.3 Define scaling factor [1)]

Enter a scaling factor separately for each axis:
Entry value > 1: workpiece will "grow"
Entry value = 1: workpiece will remain the same size
Entry value < 1: workpiece will "shrink"

Input range:	0.100000 to 9.999999
Default setting:	**1.000000**

P25 Stylus diameter [1)]

Input range (mm):	0.000 to 999.999
Default setting:	**6**

P26 Stylus length [1)]

Input range (mm):	**0.000** to 999.999

P30.1 to P30.3 Counting direction

Positive counting direction with positive direction of traverse	**DIRECT. POS**
Negative counting direction with positive direction of traverse	DIRECT. NEG

P31.1 to P31.3 Signal period of the encoder

Input range:	0.00000001 to 99999.9999 µm
Default setting:	**20 µm**

P33.1 to P33.3 Counting mode

0 - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9
0 - 2 - 4 - 6 - 8
0 - 5

P38.1 to P38.3 Decimal places

2 / **3** / 4 / 5 / 6 / 7 / 8

[1)] User parameter

P40.1 to P40.3 Select type of axis error compensation

No axis error compensation	**CORR. OFF**
Linear error compensation active, multipoint error comp. not active	CORR. LIN
Multipoint error compensation active, linear error compensation not active	CORR. ABS

P41.1 to P41.3 Linear axis error compensation

Input range (µm): –99999 to +99999
Factory default setting: **0**

Example: Displayed length L_d = 620.000 mm
Actual length (as determined for example with the VM 101 from HEIDENHAIN)
L_a = 619.876 mm
Difference $\Delta L = L_a - L_d = -124$ µm
Compensation factor k:
$k = \Delta L/L_d = -124$ µm/0.62 m = **– 200** [µm/m]

P43.1 to P43.3 Reference marks

One reference mark	SINGLE	REF.M.
Distance-coded with 500 • SP	500	SP
Distance-coded with 1000 • SP	**1000**	**SP**
Distance-coded with 2000 • SP	2000	SP
Distance-coded with 5000 • SP	5000	SP

(SP: signal period)

P44.1 to P44.3 Reference mark evaluation

Evaluation	**REF. X ON**
No evaluation	REF. X OFF

P45.1 to P45.3 Encoder monitoring

Amplitude and frequency monitoring	**ALARM ON**
No monitoring	ALARM OFF

P48.1 to P48.3 Activate axis display

Axis display active	**AXIS ON**
Not active	AXIS OFF

P49.1 to P49.3 Axis designation for measured value output

An axis designation for the measured value output can be set through the number of the ASCII character. The axis designation is output together with the measured value.

Input range:	0 to 127	
Measured value output disabled	0	
ASCII character from ASCII table	1 to 127	
Default setting:	P49.1	**88**
	P49.2	**89**
	P49.3	**90**

P50 Baud rate [1)]

110 / 150 / 300 / 600 / 1200 / 2400 / 4800 / **9600** / 19 200 / 38 400

P51 Line feeds for measured value output [1)]

Input range: 0 to 99
Default setting: **1**

[1)] User parameter

P70 Number of datum points

2 datum points	**2 DATUMS**
9 datum points	9 DATUMS

P80 Function of the CL key

Set to zero with CL	CL....RESET
No set to zero with CL	CL......OFF

P81 Function of the R+/- key

The actual value is halved by the R+/- key	R+/- 1/2 ON
The actual value is not halved.	**R+/- 1/2 OFF**

P96 Measured value output for probing

Measured value output active	PROBE ON
Measured value output not active	**PROBE OFF**

P97 Characters for measured values

ASCII characters for designation of the measured values for output through probing, contact, or pulse.

Input range:	**0** to 127
No ASCII character	0
ASCII character from ASCII table	1 to 127

P98 Conversational language [1)]

German	**LANGUAGE D**
English	LANGUAGE GB
French	LANGUAGE F
Italian	LANGUAGE I
Dutch	LANGUAGE NL
Spanish	LANGUAGE E
Danish	LANGUAGE DK
Swedish	LANGUAGE S
Finnish	LANGUAGE FI
Czech	LANGUAGE CZ
Polish	LANGUAGE PL
Hungarian	LANGUAGE H
Portuguese	LANGUAGE P

[1)] User parameter

Linear Encoders

Selecting the display step with linear encoders

To select a certain display step you must define the following operating parameters:

- Signal period (P31)
- Counting mode (P33)
- Decimal places (P38)

Example
Linear encoder with a signal period of 10 µm

Desired display step ..... 0.000 5 mm
Signal period (P31) 10
Counting mode (P33) 5
Decimal places (P38) 4

The following tables will help you select the parameters.

Parameter settings for HEIDENHAIN linear encoders with 11 μA_{PP} signals

Model	Signal period [µm]	Reference marks	Millimeters			Inches		
			Display step [mm]	Count	Decimal places	Display step [inch]	Count	Decimal places
	P 31	P 43		P 33	P 38		P 33	P 38
CT MT xx01	2	single	0.0005	5	4	0.00002	2	5
			0.0002	2	4	0.00001	1	5
LIP 401A/401R		-/single	0.0001	1	4	0.000005	5	6
			0.00005	5	5	0.000002	2	6
			Recommended only for LIP 401					
			0.00002	2	5	0.000001	1	6
			0.00001	1	5	0.0000005	5	7
			0.000005	5	6	0.0000002	2	7
LF 103/103C LF 401/401C LIF 101/101C LIP 501/501C	4	single/5000	0.001	1	3	0.00005	5	5
			0.0005	5	4	0.00002	2	5
			0.0002	2	4	0.00001	1	5
			0.0001	1	4	0.000005	5	6
LIP 101		single	0.00005	5	5	0.000002	2	6
			Recommended only for LIP 101					
			0.00002	2	5	0.000001	1	6
			0.00001	1	5	0.0000005	5	7
MT xx	10	single	0.0005	5	4	0.00002	2	5
			0.0002	2	4	0.00001	1	5
			0.0001	1	4	0.000005	5	6
LS 303/303C **LS 603/603C**	20	single/1000	0.01	1	2	0.0005	5	4
			0.005	5	3	0.0002	2	4

Parameter settings for HEIDENHAIN linear encoders with 11 µA$_{PP}$ signals (continued)

Model	Signal period [µm]	Reference marks	Millimeters			Inches		
			Display step [mm]	Count	Decimal places	Display step [inch]	Count	Decimal places
	P 31	P 43		P 33	P 38		P 33	P 38
LS 106/106C **LS 406/406C** **LS 706/706C**	20	single/1000	0.001 0.0005	1 5	3 4	0.00005 0.00002	5 2	5 5
ST 1201		-						
LB 302/302C LIDA 10x/10xC	40	single/2000	0.005 0.002 0.001 0.0005	5 2 1 5	3 3 3 4	0.0002 0.0001 0.00005 0.00002	2 1 5 2	4 4 5 5
			Recommended only for LB 302					
			0.0002 0.0001	2 1	4 4	0.000001 0.0000005	1 5	5 6
LB 301/301C	100	single/1000	0.005 0.002 0.001	5 2 1	3 3 3	0.0002 0.0001 0.00005	2 1 5	4 4 5
LIM 102	12800	single	0.1 0.05	1 5	1 2	0.005 0.002	5 2	3 3

Example:
Your encoder: LS 303 C, desired display step: 0.005 mm (5 µm), parameter settings:
P01 = mm, P43 = 1 000, P32 = 4, P33 = 5, P38 = 3

Multipoint Axis Error Compensation

If you want to use the multipoint axis error compensation feature, you must
- activate this feature with operating parameter 40 (see "Operating Parameters"),
- traverse the reference marks after switching on the display unit,
- enter a compensation value table.

Your machine may have a nonlinear axis error due to factors such as axis sag or drivescrew errors. Such deviations are usually measured with a comparator measuring system (such as the HEIDENHAIN VM 101).

You can, for example, determine the screw pitch error X=F(X) for the X axis.

An axis can only be corrected in relation to **one** axis that has an error. In each axis, a compensation value table with 64 compensation values can be generated. You can select the compensation table with the SPEC FCT key and the "PARAMETER\CODE" dialog.

To determine the compensation values (e.g. with a VM 101), the REF display must be selected after selecting the compensation-value table.

R+/-	Select the REF.

The decimal point in the left display field indicates that the displayed values are referenced to the reference point. If the decimal point blinks, the reference marks have not been traversed.

Entries in the compensation value table

- Axis to be corrected: X, Y or Z (Z axis only with ND 760)
- Axis causing the error: X, Y or Z (Z axis only with ND 760)
- Datum for the axis to be corrected:
  Here you enter the point starting at which the axis with error is to be corrected. This point indicates the absolute distance to the reference point.

  Do not change the datum point after measuring the axis error and before entering the axis error into the compensation table.

- Spacing of the compensation points
  The spacing of the compensation points is expressed as 2^X [µm].
  Enter the value of the exponent *x* into the compensation value table.
  Minimum input value: 6 (= 0.064 mm)
  Maximum input value: 20 (= 1048.576 mm)
  23 (= 8388.608 mm)

  Example: 900 mm traverse and 15 compensation points: results in 60.000 mm spacing between points. Nearest power of two: 2^{16} [µm] = 65.536 mm
  Entry in compensation value table: 16

- Compensation value
  You enter the measured compensation value (in millimeters) for the displayed compensation point. Compensation point 0 always has the value 0 and cannot be changed.

Selecting the compensation table, entering an axis correction

SPEC FCT	Select the special functions.
SPEC FCT or ↓1/↓2	Select the "Parameter" function if required, by repeatedly pressing the ↓1 ↓2 key.
PARAMETER	
ENT ↓1/↓2	Select dialog for entering the code number.
CODE	
1 0 5 2 9 6 ENT	Enter code number 105296 and confirm with ENT.
AXIS X	
X ENT	Select axis to be corrected, e.g. X. Confirm with ENT.
• • •	
X FCT. X	
X ENT	Enter the axis causing the error, e.g. X (screw pitch error), and confirm with ENT.
DATUM X	
2 7 ENT	Enter the active datum for the error on the axis to be corrected (e.g. 27 mm) and confirm with ENT.
SPACING X	
1 0 ENT	Enter the spacing of the compensation points on the axis to be corrected, for example 2^{10} µm (equals 1.024 mm) and confirm with ENT.
27.000	
ENT 0 • 0 1 ENT	Compensation point no. 1 is displayed. Enter the associated compensation value (e.g. 0.01 mm) and confirm with ENT.
• • •	

28.024	
ENT ↕1/2	Enter all further compensation points. If you press the minus key, the unit will show the number of the current compensation point in the X display. Direct selection of compensation points: Press the minus key together with the number (two-digit) of the desired compensation point.

SPEC FCT or CL	Conclude entry.

Deleting a compensation value table

SPEC FCT	Select the special functions.
SPEC FCT or ↕1/2	Select "parameter."

PARAMETER	
ENT ↕1/2	Select the dialog for entering the code number.

CODE	
1 0 5 2 9 6 ENT	Enter the code number 105296 and confirm with ENT.

AXIS X	
Z CL	Select the compensation value table (e.g., for the Z axis), and delete the table.

DELETE Z	
ENT	Confirm with ENT, or cancel with CL.
SPEC FCT	Conclude entry.

Pin Layout of X10 for KT 130 Edge Finder and Data Interface

Pin	Signal	Function
1		Internal shield
2		Standby
3	RXD	**Receive data**
4	RTS	**Request to send**
5	CTS	**Clear to send**
6		U_P +5 V
7	SIGN. GND	**Signal ground**
8		U_P 0 V
9	TXD	**Transmit data**
10	DSR	**Data set ready**
11	DTR	**Data terminal ready**
12		Meas. value output by contact
13		Switching signals
14		Meas. value output by pulse
15	CHASSIS GND	Housing

RS-232-C/V.24 (Option)

In addition to a connection for the edge finder, the X10 socket also provides an RS-232-C/V.24 data interface.

The data interface on your ND display unit enables you to use a printer or a PC for transferring measured values or programs.

The interface is permanently set to the following data format:

1 start bit
7 data bits
Even parity bit
2 stop bits

The baud rate is set with parameter P50.

For connection to peripheral devices you can use either full wiring (figure at upper right) or simplified wiring (below right).

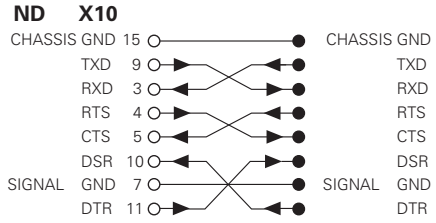
Levels for TXD and RXD

Logic levels	Voltage levels
"1"	– 3 V to – 15 V
"0"	+ 3 V to +15 V

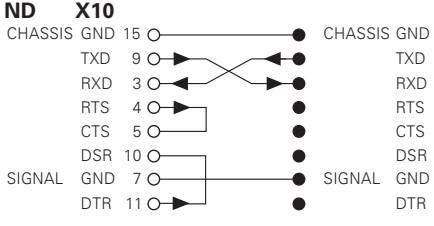
Levels for RTS, CTS, DSR and DTR

Logic levels	Voltage levels
"1"	+ 3 V to +15 V
"0"	– 3 V to – 15 V

Full wiring



Simplified wiring



Measured Value Output

Measured values can be output over the RS-232-C/V.24 interface. This can be done with the following functions:

Probing with the KT Edge Finder
Contact input on X10
Pulse input on X10
CTRL B via the RS-232-C interface

Code letters with the measured value

Parameter P97 allows you to select a code letter to be output together with the measured value when using Probe, Contact or Pulse. The decimal number you enter in the parameter is the ASCII character number in the ASCII table. If you enter 0, no code letter will be output. The code letter enables you to recognize whether the measured value was generated with CTRL B or with an external signal.

Axis designation for measured value output

Parameter P49 allows you to enter an axis designation for each measured value that is output. The decimal number you enter in the parameter is the ASCII character number in the ASCII table. If you enter 0, no axis designation will be output.

Example of measured value output:

Parameter settings:

P49.1	=	88	(“X”)
P49.2	=	89	(“Y”)
P49.3	=	90	(“Z”)
P51	=	0	(no blank lines)
P97	=	69	(“E”)

Output:

E (CR)(LF)
X=...(CR)(LF)
Y=...(CR)(LF)
Z=...(CR)(LF)

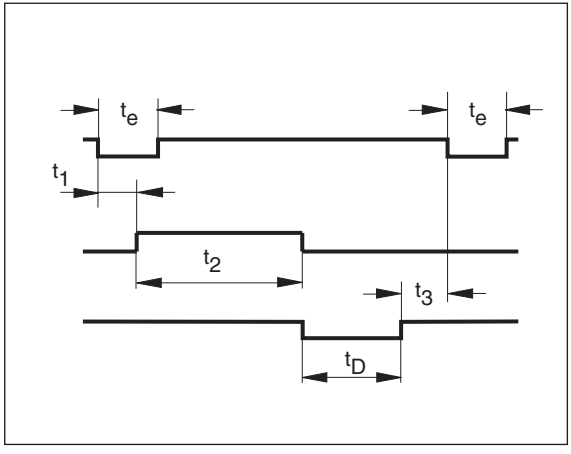
Measured value output when probing

Parameter P96 allows you to activate measured value output when probing with the KT edge finder. The edge finder is connected to D-sub input X10.

Whenever the Probe Edge function is used, your display unit outputs the position of the edge in the selected axis and the actual positions of the other axes over the TXD line of the RS-232-C/V.24 interface.

Whenever the Probe Midpoint function is used, your display unit outputs the calculated midpoint in the selected axis and the actual positions of the other axes.

Measured value output with CTRL B is disabled when a probing function is active.



Delay times with data output

Duration of the latch signal:	$t_e \geq 4$ µs
Storage delay:	$t_1 \leq 4.5$ ms
Data output after:	$t_2 \leq 50$ ms
Regeneration time:	$t_3 \geq 0$

Duration of data output in seconds:

$$t_D = \frac{209 \bullet \text{number of axes} + 11 \bullet \text{number of blank lines}}{\text{Baud rate}} * 1.08$$

Next possible signal for measured value output: $t_E = t_1 + t_2 + t_D + t_3$ [s]

Examples of measured value output when probing

Example: Probe edge, X axis

P	R	X	:	+	58541	.	2504		R	<CR>	<LF>
Y			:	−	10122	.	8660		R	<CR>	<LF>
Z			:	+	85903	.	3042	?	R	<CR>	<LF>

Example: Probe midpoint, X axis

C	L	X	:	+	34761	.	2504		R	<CR>	<LF>
Y			:	−	10122	.	8660		R	<CR>	<LF>
Z			:	+	85903	.	3042		R	<CR>	<LF>

Example: Probe circle

C	C	X	:	+	234	.	786		R	<CR>	<LF>
C	C	Y	:	+	452	.	816		R	<CR>	<LF>
Z			:	-	4563	.	305		R	<CR>	<LF>
①			②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

① Probed axis <PR>, <CL> / other axes
② Colon
③ Plus or minus sign
④ 1 to 8 places before the decimal point
⑤ Decimal point
⑥ 1 to 8 decimal places
⑦ Unit: blank = mm, " = inches, ? = error message
⑧ R = radius display, D = diameter display
⑨ Carriage Return
⑩ Line Feed

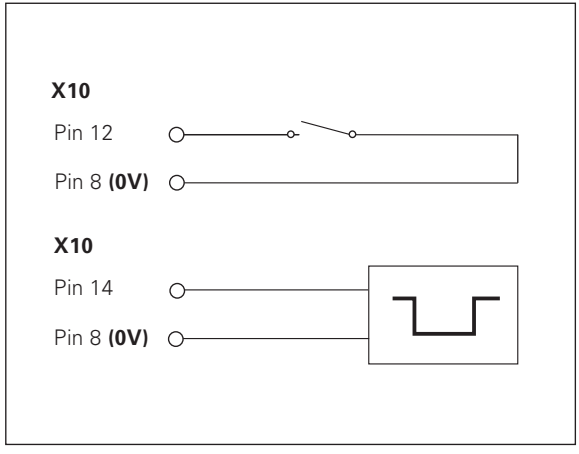
Measured value output over the contact and pulse inputs

Measured value output over the contact input (pin 12 on X10) and pulse input (pin 14 on X10) can be triggered when these inputs are closed against 0 V.

The measured values are output over the TXD line of the RS-232-C interface.

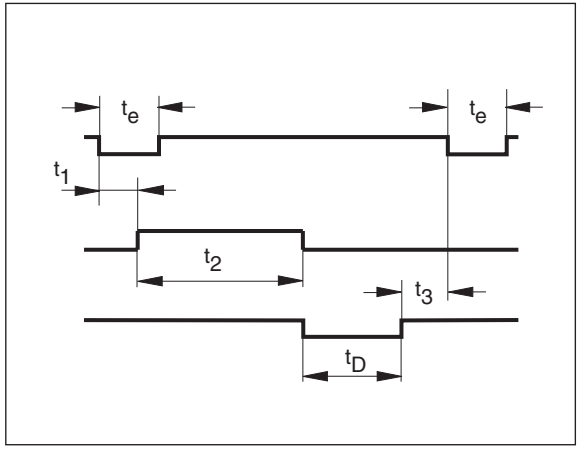
A commercially available switch can be attached to the contact input. This switch generates a signal for data output when it makes contact against 0 V.

The pulse input can be triggered with TTL logic devices (for example, SN74LSXX).



Delay times for data output

Latch signal duration: Pulse	$t_e \geq 1.2\ \mu s$
Latch signal duration: Contact	$t_e \geq 7\ ms$
Storage delay: Pulse	$t_1 \leq 0.8\ \mu s$
Storage delay: Contact	$t_1 \leq 4.5\ ms$
Data output after	$t_2 \leq 30\ ms$
Regeneration time	$t_3 \geq 0$



Duration of data output in seconds:

$$t_D = \frac{187 \bullet \text{number of axes} + 11 \bullet \text{number of blank lines}}{\text{Baud rate}} * 1.08$$

Next possible signal for measured value output: $tE = t_1 + t_2 + t_D + t_3$ [s]

Measured value output with CTRL B

If the control character STX (CTRL B) is received over the RS-232-C interface, the measured value referenced to this time point will be sent over the interface. CTRL B is received over the RXD line and the measured values are output over the TXD line.

BASIC program for measured value output:

```
10    L%=48
20    CLS
30    PRINT "RS232/V.24"
40    OPEN "COM1:9600,E,7" AS#1
50    PRINT #1, CHR$ (2);
60    IF INKEY$<>""THEN 130
70    C%=LOC(1)
80    IF C%<L%THEN 60
90    X$=INPUT$(L%,#1)
100   LOCATE 9,1
110   PRINT X$;
120   GOTO 50
130   END
```

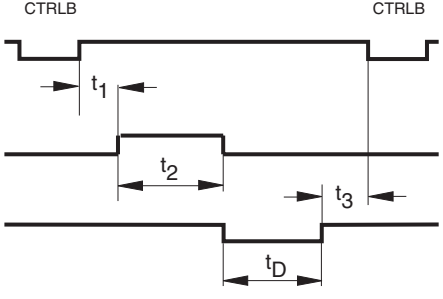
Delay times for data output

Storage delay	$t_1 \leq 0.5$ ms
Data output follows t_2	$t_2 \leq 30$ ms
Regeneration time after data output	$t_3 \geq 0$ ms

Duration of data output in seconds:

$$t_D = \frac{187 \bullet \text{number of axes} + 11 \bullet \text{number of blank lines}}{\text{Baud rate}} * 1.08$$

Next possible signal for measured value output: $t_E = t_1 + t_2 + t_D + t_3$ [s]



Example of measured value output over the contact and pulse inputs or CTRL B:

E	<CR>	<LF>							
X	=	+	58541	.	2504		R	<CR>	<LF>
Y	=	-	10122	.	8660		R	<CR>	<LF>
Z	=	+	85903	.	3042		R	<CR>	<LF>
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

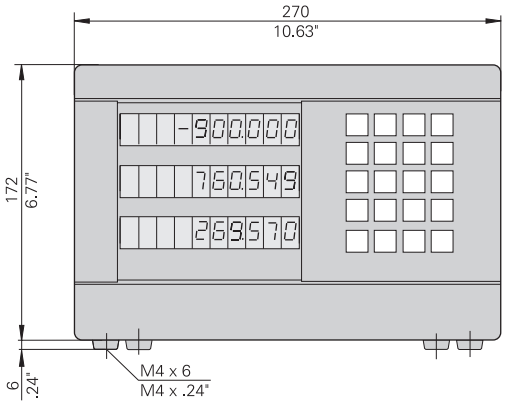
① Axis designation
② Equality sign
③ Plus or minus sign
④ 1 to 8 places before the decimal
⑤ Decimal point
⑥ 1 to 8 places after the decimal
⑦ Unit: blank = mm, " = inches, ? = error message
⑧ R(r) = radius display, D(d) = diameter display, ( ) = distance-to-go display
⑨ Carriage Return
⑩ Line Feed

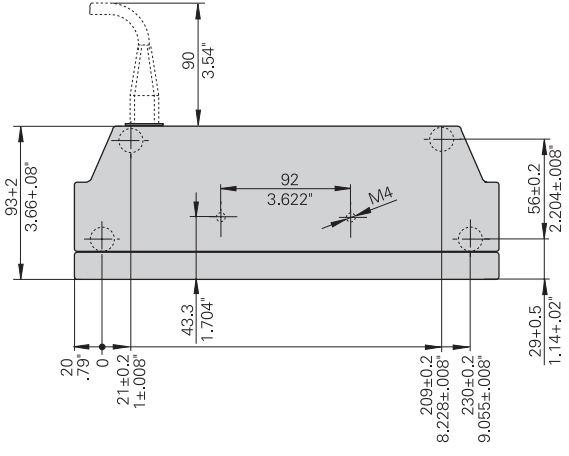
Specifications

Housing	ND 720/ND 760 Bench-top design, cast-metal housing Dimensions (W • H • D) 270 mm • 172 mm • 93 mm
Oper. temperature	0° to 45° C (32° to 113° F)
Storage temperature	–20° to 70° C (–4° to 158° F)
Weight	Approx. 2.3 kg (5 lb)
Relative humidity	<75% annual average <90% in rare cases
Power supply	100 Vac to 240 Vac (–15% to +10%) 50 Hz to 60 Hz (± 2 Hz)
Power consumption	15 W
Protection	IP 40 as per IEC 529

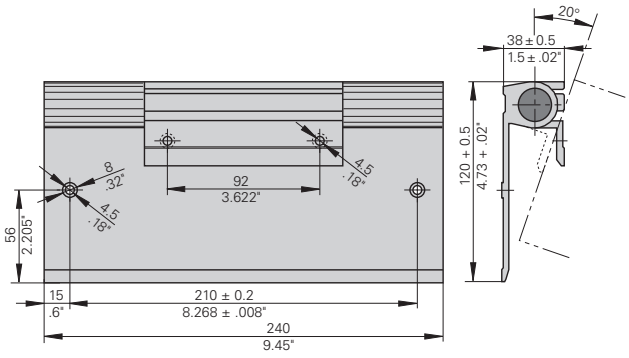
Encoder inputs	For encoders with 7 to 16 μA_{PP} Grating period 2, 4, 10, 20, 40, 100, 200 µm and 12.8 mm Reference mark evaluation for distance-coded and single reference marks
Input frequency	Max. 100 kHz for 30 m (98.5 ft) cable length
Display step	Adjustable (see "Linear Encoders")
Datums	2 (nonvolatile)
Functions	– Tool radius compensation – Distance-to-go display – Probing functions – Circular & linear hole patterns – Scaling factor – Measured value output
RS-232/V.24 interface	Baud rates adjustable 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19 200, 38 400

Dimensions in mm/inches





Tilting base



HEIDENHAIN

DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut, Germany
☎ +49/86 69/31-0
FAX +49/86 69/50 61
e-mail: info@heidenhain.de

☎ **Service** +49/86 69/31-12 72
☎ TNC-Service +49/86 69/31-14 46
FAX +49/86 69/98 99
e-mail: service@heidenhain.de

http://www.heidenhain.de

HEIDENHAIN (G.B.) Limited
200 London Road, Burgess Hill
West Sussex RH15 9RD, Great Britain
☎ (01444) 24 77 11
FAX (01444) 87 00 24

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